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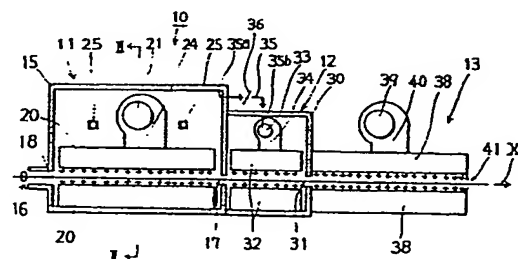
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(54) Method and apparatus of conveying strip materials.

(57) Method and apparatus for conveying strip materials in a floated manner whereby a strip (18) is allowed to pass between a pair of chambers (20/20, 32/32, 38/38) vertically spaced apart from each other and provided with a plurality of jets or blowoff openings at one surface thereof so that jets of gases are blown therefrom against the strip so as to float the strip. If the strip to be conveyed is of a smaller width, then the width of the gas stream blown from the lower chamber is correspondingly reduced so that a saving of energy required for blowing the gases may be achieved.

FIG. 1



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- Beibehaltung
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METHOD AND APPARATUS OF CONVEYING STRIP MATERIALS

Background of the Invention

1. Field of the Invention

This invention relates to a method and an apparatus of continuously conveying strips of metal such as aluminum or of many other different materials in a floated manner.

5 2. Description of the Prior Art

When a strip of metal or other different material is passed through a heat-treatment apparatus, the strip is floated by a blowoff chamber which blows jets of gases against the strip from a plurality of blowoff openings provided through an upper surface of the chamber. The blowoff openings are arranged in such a number and manner that all the strips of up to maximum width to be treated are floated thereby.

The required capacity of a device for supplying the strip-floating gases to the blowoff chamber is determined as follows:

$$V = \sqrt{\frac{\alpha t}{B}} \dots\dots\dots (1)$$

(where V is the blowoff speed of strip-floating gases; t, thickness of the strip; α , coefficient; and B is width of the strip.)

That is, the smaller the width of the strip, the

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1 higher blowoff speed of strip-floating gases is re-
quired, and it is required for the device to have
such a maximum supply rate as allows the gases to
blow off through the blowoff chamber, from all the
5 blowoff openings thereof, at the highest speed which
causes the strip of smallest width to be floated.

With reference to Fig. 7 of the accompanying draw-
ings, if the blowoff chamber of 2,029 mm. in width
is required to blow gases at a supply rate of 500 Nm^3
10 in order to float a strip of 1,829 mm. in width,
the same chamber must blow off the gases at a supply
rate of approximately 870 Nm^3 per minute in order
to float a strip of 610 mm. in width. Therefore,
if the strips to be heat treated are of widths of
15 610 mm. to 1,829 mm., the device for supplying the
strip-floating gases to the blowoff chamber is re-
quired to have a considerably great supply capacity,
i.e., maximum supply rate of 870 Nm^3 in order to float
all the strips to be treated.

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Summary of the Invention

It is an object of the invention to provide a method
of conveying strips of metal or other different materials
which is characterized in floating the strips in an equal-

1 ly reliable manner, whether they are larger or smaller in width, while conveying them.

Another object of the invention is to provide a method of conveying strips of metal or other different materials which is characterized in that the smaller the width of the strip to be conveyed, the smaller the rate of supply of gases required for floating the strip although the strips, whether of a larger or smaller width, are floated in an equally reliable manner.

10 When this object is achieved, a means for supplying the strip-floating gases to a blowoff chamber may be of a lighter duty than required if otherwise.

Other objects and advantages of the invention will become apparent during the following discussion of the accompanying drawings.

Brief Description of the Drawings

Fig. 1 is a schematic vertical cross section of a heat-treatment apparatus according to the invention;

20 Fig. 2 is another vertical cross section of the apparatus of Fig. 1 taken on the line II-II of Fig. 1;

Fig. 3 is a partially-broken perspective view of one of two plenum chambers used in a heating device provided in the apparatus of Fig. 1;

1 Figs. 4, 5, and 6 each show a strip material in
heat treatment by the apparatus of Fig. 1 and a low-
er one of the two plenum chambers floating the strip
material with a particular gas-blow width suitable for
5 the particular width of the material;

Fig. 7 is a graph showing the relationship between
the widths of strips and the supply or blowoff rate of gas by
a fan required for floating the strips;

Fig. 8 shows the arrangement or distrubution of
10 blowoff openings provided in one of the two plenum
chambers identical to the other chamber in construc-
tion;

Fig. 9 is an enlarged view of some of the blowoff
openings of Fig. 8;

15 Fig. 10 is a partially-broken perspective view of
another embodiment of a plenum chamber different from
the preceding ones in a gas blowoff-width adjusting
mechanism;

Fig. 11 is also a partially-broken perspective view
20 of a further embodiment of a plenum chamber different
from the preceding ones in the gas blowoff-width adjust-
ing mechanism;

Fig. 12 is a vertical cross section of the mechanism
of Fig. 11;

25 Fig. 13 is a side elevation of the mechanism of

1 Fig. 11;

Fig. 14 is a side elevation of a still another embodiment of a plenum chamber different from the preceding ones in the gas blowoff-width adjusting mechanism;

Fig. 15 is also a side elevation of a still further embodiment of a plenum chamber different from the preceding ones in the gas blowoff-width adjusting mechanism;

10 Fig. 16 is a plan view of a still another embodiment of a plenum chamber different from the preceding ones in the gas blowoff-width adjusting mechanism;

Fig. 17 is a side elevation of the mechanism of Fig. 16;

15 Figs. 18 and 19 each show a floating relationship between a strip material and the lower plenum chamber, similar to but different from those of Figs. 5 and 6 in the setting of blowoff width of the strip-floating gas;

20 Fig. 20 is a similar graph to that of Fig. 7 but which shows a different relationship between the widths of strips and the blowoff rate of strip-floating gas;

Fig. 21 is a vertical cross section of blast duct and surplus-gas discharge means connected thereto;

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1 Fig. 22 is a cross section of the duct and discharge means of Fig. 21 taken on the line XXII-XXII of Fig. 21;

5 Fig. 23 is a horizontal cross section of a different combination of duct and discharge means from that of Fig. 21; and

 Fig. 24 is a cross section of the combination of Fig. 23 taken on the line XXIV-XXIV of Fig. 23.

10 Description of the Preferred Embodiments

 Referring to Figs. 1 and 2, an apparatus 10 for heat-treating metal strips comprises a heating device 11, slow-cooling device 12, and full-cooling device 13.

15 The heating device 11 is defined by a furnace wall 15 which, as is well known in the art, is so constructed as to isolate heat inside and outside the device 11 from each other and is provided with an introduction port 16 and an insertion opening 17 which allow a metal

20 strip 18 to be inserted therethrough. The heights of the port 16 and opening 17 are so determined that the metal strip 18 is allowed to pass therethrough with no damage given to the strip 18 and that the amount of gases passing therethrough is minimized. Also, the widths

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1 of the port 16 and opening 17 are so determined that
the widest strip of all the metal strips to be heat-
treated is passed therethrough with no damage given
to the strip.

5 Inside the furnace wall 15 are provided a pair of
plenum chambers 20 vertically spaced apart from each
other so that the strip 18 is allowed to pass there-
through. The upper and lower plenum chambers 20 are
provided with a plurality of openings (designated by
10 numeral 57 in Fig. 9) made through the bottom and the
top thereof, respectively, for blowing jets of gases
against the strip 18. The plenum chambers 20 each
have a width larger than the widest strip of all the
metal strips to be heat-treated. Also the breadth-
15 wise distribution of the blowoff openings of each
chamber 20 is such that the openings cover a range
slightly larger than the breadth of the foregoing
widest strip.

The furnace wall 15 is also provided with a pair
20 of gas-supply means such as circulating fans 21 ex-
tending through the wall 15 and each having an intake
port 22 and supply port 23 (Fig. 2). As clearly shown
in Fig. 2, a blast duct 24 is connected to the supply
port 23 of one circulating fan 21 at one end thereof

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1 and to the upper plenum chamber 20 at the other end
thereof, while another blast duct 24 is connected to
the supply port 23 of the other circulating fan 21
at one end thereof and to the lower plenum chamber
5 20 at the other end thereof. In Fig. 2 the right-
hand blast duct 24 and the left-hand one 24 there-
fore are adapted to supply gas (from the circulating
fans 21) to the upper chamber 20 and the lower cham-
ber 20, respectively. However, the left-hand cir-
10 culating fan 21 and blast duct 24 may not be pro-
vided if instead of them (21 and 24) a blast duct 24'
is connected to the supply port 23 of the right-hand
circulating fan 21 at one end thereof and to the upper
chamber 20 at the other end thereof so that the two
15 right-hand blast ducts 24' and 24 supply gas to the
upper chamber 20 and to the lower chamber 20, respec-
tively. In such a case, the blast duct 24' may be
provided with a dumper 24" to be opened in the re-
quired amount for the suitable rate of supply of gas
20 to the upper chamber 20.

As with the heating device 11, the slow-cooling
device 12 includes a furnace wall 30, an insertion open-
ing 31, a pair of plenum chambers 32, a pair of circulat-
ing fans 33, and their associated blast ducts 34. The

1 circulating fans 33 each have an intake port connect-
ed to one end 35b of heated-gas supply pipe 35 which
is connected to and opened into the heating device 11
at the other end 35a thereof so that the gas heated
5 in the device 11 is allowed to streamtherethrough to
the fan 33. The heated-gas supply pipe 35 is provided,
at a middle portion thereof, with a dumper 36 for con-
trolling the amount of the heated gas to be supplied
to the fan 33 or slow-cooling device 12.

10 The third component or full-cooling device 13 is
of a similar construction to that of the heating de-
vice 11 except that no furnace wall or burners are
provided; that is, the full-cooling device 13 includes
a pair of plenum chambers 38, a pair of air-blast
15 fans 39, their associated blast ducts 40, and strip-
discharge opening 41.

In Fig. 1 it is to be noted that only one of each
pair of circulating fans (21, 33, and 39) is shown.

Referring to Fig. 3, the lower one of the two plenum
20 chambers 20 in the heating device 11 (which chamber 20,
when turned upside down, is identical with the upper
chamber 20 in construction) is of a box-shaped construc-
tion comprising a top plate 44, bottom plate 45, and
side plates 46 and 47. As previously mentioned, the
25 top plate 44 is provided with a plurality of blowoff

1 openings (although not shown in Fig. 3). A pair of
support plates 48 are connected to the inside surfaces
of top plate 44 and side plates 46. Each support plate
48 has a pair of guide holes 49 each of which allows
5 a bar 50 to pass therethrough at one end thereof. Each
bar 50 therefore is inserted through the two opposite
guide holes 49 and supported by the two opposite support
plates 48 at both ends thereof. A pair of cylinders
52 including advance/retreat rods 53 are connected to
10 each bar 50 through installation holes 51 made through
the side plate 46 and each allowing the piston rod 53
to pass therethrough. Outside the plenum chamber 20
the cylinders 52 are also supported by cylinder supports
(not shown) at their respective outside ends. Each
15 piston rod 53 is adapted to move at right angles to
the side plate 46 so as to displace the bar 50 along
the guide holes 49. Each bar 50 is provided with a
shutter 54 connected to the substantially entire length
of the bar 50 (i.e., the range indicated by L in Fig. 3)
20 so as to move together with the bar 50 when the bar is
displaced along the guide holes 49 by the piston rods
53. Such movements of the bars 50 and shutters 54 are
shown in Figs. 4 (retracted position), 5, and 6. When
the shutters 54 are thus moved (Figs. 5 and 6), all of
25 the blowoff openings of the top plate 44 then located

1 directly above the shutters are closed. Therefore,
the cylinders 52, bars 50, and shutters 54, as major
components, constitute a gas-blowoff width adjusting
mechanism.

5 The plenum chambers 32 of the slow-cooling device
12 and those 38 of the full-cooling device 13 are of
a construction identical to those of the plenum cham-
bers 20 of the heating device 11, and no description
will be given to the construction of the chambers 32
10 and 38.

Referring again to Figs. 1 and 2, the apparatus 10
of the above-mentioned construction is operated as fol-
lows: In the heating device 11 the burners 25 are op-
erated to heat the atmosphere in the device 11, and
15 the circulating fans 21 are also operated so that the
heated gas is drawn from their intake ports 22 and
supplied into the plenum chambers 20 through the sup-
ply ports 23 and blast ducts 24. From the chambers
20 the gas is blown off through their blowoff openings
20 to the passage of the strip 18 between the two cham-
bers 20. In the slow-cooling device 12 moderately warm
gas is blown from the plenum chambers 32 in the same
manner as in the first device 11. In the full-cooling
device 13, cooling air of the normal temperature is blown
25 from the plenum chambers 38 in the same manner as in the
first device 11. Into the heat-treatment apparatus 10
thus operated is inserted the metal strip 18 as shown
in Fig. 1. The strip 18 inserted is conveyed by a con-

veyance mechanism (not shown) in a direction indicated by X in Fig. 1 while being floated by the gases blown from the plenum chambers 20, 32, and 38.

When the metal strip 18 is thus passed through the apparatus 10, the strip 18 is first heated to a high temperature (e.g., 450°C) by the heating gas blown from the plenum chambers 20 of the first device 11, and is then cooled, with a gentle temperature gradient, to a medium temperature (e.g., 250°C) by the moderately warm gas blown from the plenum chambers 32 of the second device 12. Lastly the strip 8 is cooled, with a sharp temperature gradient, to the normal temperature by the cooling gas blown from the plenum chambers 38 of the third device 13.

Description is then given to different operations to be made for the particular widths of the metal strips to be conveyed.

(1) For the widest one of all the strips to be conveyed

For the conveyance of the widest metal strip, the shutters 54 are held in their fully-retracted positions, as shown in Fig. 4, so that no blowoff openings of the chamber top 44 are closed by the shutters 54. In addition, the supply rate of the heated gas by the circulating fans 21 is set at the predetermined maximum rate for

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1 the maximum strip width.

Under these conditions the heating gas is blown from all the blowoff openings of the plenum chambers 20 against the strip 18 at the optimum speed for floating the strip. The strip is therefore allowed to travel in the direction X (Fig. 1) in a steadily-floated condition.

(2) For a strip of medium width

For the conveyance of a strip of medium width or a little smaller width than that of the widest strip, the shutters 54 both are moved inward by a certain amount so that some of the blowoff openings of the chamber 20 are closed, setting the gas blowoff-width at a range W as shown in Fig. 5. As clearly shown in Fig. 5, the blowoff width W preferably is slightly larger than the width of the strip; for example, if the strip is of a width of 1,200 mm., the blowoff width W is preferably 1,400 mm.

For the conveyance of such a strip, the supply rate of the heating gas of the circulating fans 21 is determined as follows: The smaller the width of the strip, the higher blowoff speed of the gas is required in order to float the strip. If the gas-supply rate of the fans 21 is set at the same as in the foregoing case (1) for

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1 the gas-blowoff width W of Fig. 5, the blowoff speed
of the gas from the chambers 20 is increased compared
with that of the case (1), but exceeds the optimum
speed for floating the strip (of Fig. 5). Therefore,
5 the supply rate of gas of the fans 21 must be reduced
to such a degree that the the blowoff speed of the gas
from the chambers 20 becomes the optimum one for float-
ing of the strip. One of the methods of reducing the
gas-supply rate of the fans is to reduce the electric
10 power supplied to the electric motor for operating the
fans.

With the gas-blowoff width set at W and the gas-
supply rate of the fans 21 determined in the foregoing
manner, the strip of medium width is conveyed in a
15 steadily-floated condition.

(3) For a strip of smaller width

For the conveyance of a strip of considerably small-
er width such as one shown in Fig. 6, the shutters 54
are moved more inward than in the foregoing case (2)
20 so that the gas-blowoff width W becomes further reduced
(Fig. 6). As in the case (2), the gas-blowoff width W
preferably is a little larger than the width of the strip;
for example, if the strip is of a width of 610 mm., the
blowoff width W may be preferably 800 mm. or so. In addi-

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1 tion, the gas-supply rate of the fans 21 is so adjust-
ed that the gas-blowoff speed becomes the optimum one
for floating the strip.

Under these conditions the strip of smaller width
5 is conveyed in a steadily-floated manner.

In the foregoing cases (2) and (3) it is to be noted
that since no surplus gas is supplied from the circulat-
ing fans 21, a saving of the electric power required
for operating the fans is achieved.

10 After passing through the heating device 11 in the
foregoing manner, the foregoing each strip of the par-
ticular width is then conveyed through the slow-cooling
device 12 and full-cooling device 13 in the same manner
as in the heating device 11.

15 Referring to Fig. 7 showing a relationship between
the widths of metal strips and the supply rate of gas
of the circulating fan required for the steady floating
of the strips, if a strip of the width indicated by A
in Fig. 7 (which is the width of the strip of Fig. 4)
20 is to be floated by the plenum chamber 20 of Fig. 3,
the circulating fan must have a gas-supply rate indicated
by A' of Fig. 7. Also, if the strip to be floated is
of a smaller width indicated by B of Fig. 7 (which is
the width of the strip of Fig. 5), then the gas-supply

1 rate of the fan must be set at the value indicated
by B' of Fig. 7 which is smaller than the value A'
for the previously-mentioned reason. Lastly, if
the strip to be floated is of a still smaller width
5 indicated by C of Fig. 7 (which is the width of the
strip of Fig. 6), then the fan must have a gas-supply
rate indicated by C' of Fig. 7 which is still smaller
than the value B'. Therefore the circulating fans for
the apparatus 10 may be designed with the maximum rate
10 of gas supply indicated by the value A'.

It is to be noted that the relationship of Fig. 7
is under the conditions that the plenum chamber is
of a length of 8 meters (dimension in the direction
of strip conveyance) and that the strips are of a
15 thickness of 0.4 millimeters.

Referring to Figs. 8 and 9 showing the arrangement
or distribution of the blowoff openings 57 of the chamber
top 44, the blowoff openings 57 are located, in small
groups, on a plurality of imaginary zigzag lines drawn
20 along the lengthwise direction of the top plate 44 or
the strip-conveyance direction X. Such an arrangement
of the blowoff openings 57 allows the openings to be
closed or opened by a small number at a time as the
shutters 54 are moved inward or outward of the chamber

1 20, so that the gas-blowoff width W of the top plate
44 may be varied by a small amount at a time for a
wide variety of strip widths.

5 Referring to Fig. 10, a plenum chamber 20e is differ-
ent from the preceding one 20 (32 or 38) in a gas blow-
off-width adjusting mechanism. That is, the adjusting
mechanism herein includes a pair of cylinders 59 dis-
posed inside the chamber 20e. The cylinders 59 each
10 have a cylinder body 60 connected to a bottom plate
45e of the chamber by means of an upright support 61
and have a pair of piston rods 62 connected to a pair
of bars 50e, respectively, by means of a pair of an-
gular supports 63. The piston rods 62 are adapted to
15 move at right angles to the direction of strip convey-
ance in a simultaneous and symmetrical manner so that
the bars 50e, together with shutters (not shown) con-
nected thereto, are moved in a simultaneous and sym-
metrical manner.

20 In the foregoing second embodiment of gas blowoff-
width adjusting mechanism and the similar embodiments
that follow hereinafter, parts or portions exactly or
substantially identical to those of the foregoing first
embodiment 20 are designated by the same numerals as
those of the preceding portions and alphabets e, f,

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1 g, h, and i.

Referring to Figs. 11, 12, and 13, a plenum chamber 20f is also different from the preceding ones in a gas blowoff-width adjusting mechanism. The plenum
5 chamber 20f herein includes a pair of groups of bars 66 which are rotatably supported, beneath a top plate 44f, by bearings 65 and each are provided with a shutter means 67. Each bar 66 projects from one side plate 47f at one end thereof, and the projecting end is
10 provided with a contact piece 68. When being in upright positions as shown in Figs. 11 and 12, the shutter means 67 close no blowoff openings of the top plate 44f, but are adapted to close them when the means 67 are rotated to the horizontal positions by a shutter-operating means
15 69 which includes a base 70 and an air cylinder 71. The air cylinder 71 is provided with a pair of piston rods 72 and 73 having shutter-operating plates 74 and 75, respectively, on the upper surfaces thereof. The piston rods 72 and 73 are adapted to move at right angles to
20 the direction of strip conveyance in a simultaneous and symmetrical manner, so that when the shutter-operating plate 74 on the rod 72 is moved to the right-hand side in Fig. 13, the opposite plate 75 is moved to the left-hand side in the same Fig. As is clearly shown in the
25 same Fig., when these plates 74 and 75 are thus moved,

1 the contact pieces 68 of the bars 66 are rotated to
the horizontal positions successively with the most
outward first and the most inward last, so that the
shutter means 67 (not shown in Fig. 13) of the bars
5 66 are simultaneously rotated to the horizontal po-
sitions, successively closing the blowoff openings of
the top plate 44f. The gas-blowoff width of the top
plate 44f is thus adjusted.

Referring to Fig. 14, a plenum chamber 20g is also
10 different from the preceding ones in a gas blowoff-width
adjusting mechanism. More particularly, the plenum
chamber 20g is different from the preceding chamber
20f in a shutter-operating means 77 of the gas blowoff-
width adjusting mechanism. The shutter-operating means
15 77 (corresponding to the means 69 of the preceding cham-
ber 20f) includes a pair of sprockets 78 and 79 carry-
ing a chain 80 which is provided with a plurality of
shutter-operating pieces 81, and also includes a pair
of sprockets 82 and 83 carrying a chain 84 which is pro-
20 vided with a plurality of shutter-operating pieces 85.
A reversible motor 86 is connected to the sprocket 78.
The sprockets 79 and 82 are engaged with each other.
In this construction, when the reversible motor 86 is
rotated in a counterclockwise direction (in Fig. 14),
25 the sprockets 78 and 79 are also rotated in the same

1 direction with the shutter-operating pieces 81 of
the chain 80 successively rotating contact pieces 68g
to the horizontal positions, while the sprockets 82
and 83 are rotated in the clockwise direction with the
5 shutter-operating pieces 85 of the chain 84 successive-
ly rotating the other group of contact pieces 68g to the
horizontal positions. That is, when the motor 86 is
operated, the shutter-operating pieces 81 and 85 are
moved in a simultaneous and symmetrical manner.

10 Referring to Fig. 15, a plenum chamber 20h is also
different from the preceding ones in a gas blowoff-width
adjusting mechanism. More particularly, the plenum cham-
ber 20h is different from the preceding chamber 20g in
that a pair of sprockets 78h and 79h are separated from
15 another pair of sprockets 82h and 83h and reversible
motors 86h and 88 are connected to the sprockets 78h and
83h, respectively. The reversible motors 86h and 88
are adapted to rotate simultaneously or synchronously
in the opposite directions. In this construction,
20 when the motor 86h is rotated in a counterclockwise
direction (in Fig. 15) and the other motor in the oppo-
site direction, shutter-operating pieces 81h and 85h
rotate contact pieces 68h successively to the horizontal
positions.

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1 Referring to Figs. 16 and 17, a plenum chamber 20i
is also different from the preceding ones in a gas
blowoff-width adjusting mechanism. More particularly,
in the adjusting mechanism herein, bars 66i of each
5 group project from the chamber 20i by different dis-
tances and a shutter-operating board 90 is provided
for each pair of bar projections having the same length.
The shutter-operating board 90 has a pair of shutter-
operating pieces 91 and 92 located on the upper surface
10 thereof and adapted to engage with contact pieces 68i
of the bar projections, and is connected to a cylinder
93 so that the board 90 is moved thereby at right angles
to the direction of strip conveyance. Therefore in this
mechanism, unlike in those of Figs. 11 to 15, the shutter
15 means (not shown in Fig. 16) located inside the chamber
20i are operated not symmetrically, but in the same di-
rection.

Referring to Figs. 18 (corresponding to Fig. 5) and
19 (corresponding to Fig. 6), another method of float-
20 ing strips may be carried out as required, instead of
the method described in connection with Figs. 4, 5, and
6; that is, although in the preceding method the supply
rate of gas from the circulating fan 21 is varied for
the different widths of strips and accordingly-adjust-

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1 ed gas-blowoff width so that the blowoff speed of gas
from the chamber becomes the optimum one for floating
the strip, the supply rate of gas from the fan may be
kept at the same or maximum value (determined for the
5 floating the widest one of all strips to be treated)
for floating all the strips of different widths to be
treated. And when this method is followed, the gas-
blowoff width W (Fig. 18) for a strip 18 (of the same
width as the strip of Fig. 5) is set at a larger range
10 than the required blowoff width W' (indicated by W in
Fig. 18) in the method of Fig. 5, by a certain amount.

Further referring to Fig. 20 similar to Fig. 7,
the gas-blowoff width W of the method of Fig. 18 is
so determined that the gas supplied for the strip 18
15 of a width indicated by B in the maximum amount or rate
indicated by A' (set for the widest strip A) floats the
strip 18 by the supply rate B' which would be required
for the preceding method of Fig. 5, with the remaining
portion of the gas (A' - B') discharged from the differ-
20 ence between the blowoff width W and smaller width W',
without playing any part in the floating the strip.
The blowoff width W of Fig. 19 for a strip 18 of the
same width as the strip of Fig. 6 is determined in the
same manner as in the method of Fig. 18.

- 1 It is to be noted that the relationship of Fig. 20
is under the conditions that the plenum chamber is of
a length of 8 meters and that the strips are of a thick-
ness of 0.4 millimeters.
- 5 There is more waste of the strip-floating gases in
the foregoing alternative floating method compared with
the first method of energy-saving type; however, the
strip is conveyed by the alternative method with the
same degree of steady floating as by the first method.
- 10 Also, the second method has the advantages that there
is no need to vary the gas supply rate of the fan and
that, as in the first method, the circulating fan may
be designed with the maximum rate of gas supply indicat-
ed by A' of Fig. 20. Although the gases discharged with-
15 out playing any part in the strip floating must be con-
trolled in a slight amount in the second method, such
a control may be made easily.

Referring to Figs. 21 and 22, the foregoing surplus
gas may be earlier discharged from a blast duct 24j,
20 instead of being discharged from the chamber. That is,
the blast duct 24j includes a surplus-gas discharge
means 95 connected thereto in its middle portion and
having a rotatable shaft 96 inserted therethrough.
The discharge means 95 includes a discharge port 95',

1 and the shaft 96 is provided with a dumper 97 for adjust-
ing the opening amount of the discharge port 95' so as
to controll the amount of surplus gas to be discharged.
The shaft 96 also has a lever 100 outside the discharge
5 means 95 which lever 100 is connected to a piston rod
99 of a cylinder 98 installed onto the outside surface
of a furnace wall 15j. In such a surplus-gas discharge
mechanism, the cylinder 98 is operated to open the dumper
97 in the required amount for discharging the surplus
10 gas from the discharge port 95' into the space enclosed
by the furnace wall 15j.

Referring to Figs. 23 and 24, a blast duct 24k is
provided outside a furnace wall 15k, and is provided
with a surplus-gas discharge means including three dump-
15 ers 97k for controlling the amount of surplus gas to be
discharged. The dumpers 97k are all opened or closed
simultaneously by the action of a cylinder 98k.

As many apparently widely different embodiments of
the invention may be made without departing from the
20 spirit and scope thereof, it is to be understood that
the invention is not limited to the specific embodiments
thereof except as defined in the appended claims.

1 WHAT IS CLAIMED IS:

1. A method for conveying strip materials while float-
ing the strip by blowing jets of gases against the strip
from a pair of chambers vertically separated from each
5 other with a strip-conveyance passage disposed there-
between, including the steps of:
 - a. adjusting the width of blowoff of gas from the
lower one of said chambers in accordance with
the particular width of the strip to be conveyed; and
 - 10 b. controlling the rate of supply of gas to said
lower chamber so that the speed of gas blown
against the strip with said adjusted blowoff
width is set at such a value as allows the strip
to be floated in a steady manner.
- 15 2. A method in accordance with claim 1 wherein said
adjustment of gas-blowoff width of said lower chamber
is effected by moving a plurality of shutters along
the top of said lower chamber including a plurality
20 of blowoff openings and in directions perpendicular
to the direction of strip conveyance.
3. A method in accordance with claim 1 wherein said
adjustment of the speed of gas blown against the strip
25 is effected by controlling the output of power of a

1 gas supply means connected to said lower chamber.

4. A method for conveying strip materials while float-
ing the strip by blowing jets of gases against the strip
5 from a pair of chambers vertically separated from each
other with a strip-conveyance passage disposed there-
between, including the steps of:

- 10 a. adjusting the width of blowoff of gas from the
lower of said chambers in accordance with the
particular width of the strip to be conveyed; and
- b. discharging a portion of the gas supplied into
said lower chamber from a place outside of said adjusted
blowoff width so that the speed of the gas blown
against the strip from said adjusted blowoff width
15 is set at such a value as allows the strip to be
floated in a steady manner.

5. A method in accordance with claim 4 wherein said
gas-blowoff width is determined in a larger range than
20 the width to be adjusted in accordance with the partic-
ular width of the strip and said discharge of a portion
of the gas is effected from the portion of said deter-
mined blowoff width located outside of the blowoff width
to be adjusted in accordance with the particular width
25 of the strip.

1 6. A method in accordance with claim 4 wherein said
discharge of a portion of the gas is effected from
a discharge port located in a middle of a gas-supply
pipe for said lower chamber.

5 7. An apparatus for conveying strip materials (18) while
floating the strip by blowing jets of gases against the
strip from a pair of chambers (20/20, 32/32, 38/38) verti-
cally separated from each other with a strip-conveyance
10 passage disposed therebetween, including:

a. means (54, 67) for adjusting the width of blowoff
of gas from the lower one of said chambers (20, 32,
38) in accordance with the particular width of the
strip (18) to be conveyed; and

15 b. means controlling the rate of supply of gas to
said lower chamber so that the speed of gas
blown against the strip (18) with said adjusted
blowoff width is set at such a value as allows
the strip to be floated in a steady manner.

20 8. An apparatus for conveying strip materials (18) while
floating the strip by blowing jets of gases against the
strip from a pair of chambers (20/20, 32/32, 38/38) verti-
cally separated from each other with a strip-conveyance
25 passage disposed therebetween, including:

- 1 a. means (54, 67) for adjusting the width of blow-
 off of gas from the lower of said chambers (20,
 32, 38) in accordance with the particular width
 of the strip (18) to be conveyed; and
- 5 b. means (gap W-W' of Fig. 18 and 19, 97) for dis-
 charging a portion of the gas supplied into said
 lower chamber from a place outside of said adjusted
 blowoff width (W') so that the speed of the gas
 blown against the strip (18) from said adjusted
10 blowoff width is set at such a value as allows
 the strip to be floated in a steady manner.

15

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FIG. 1

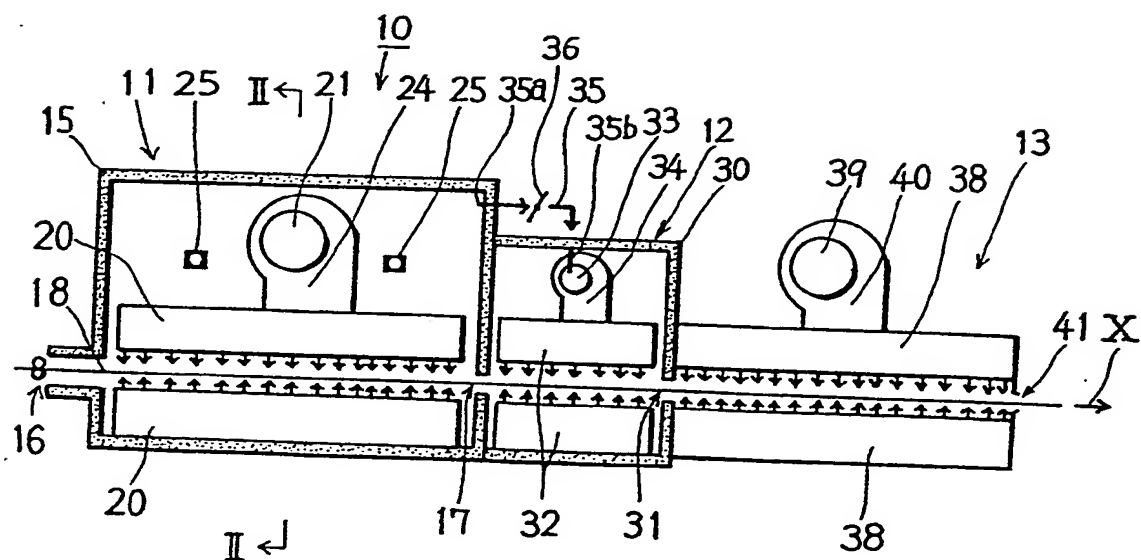
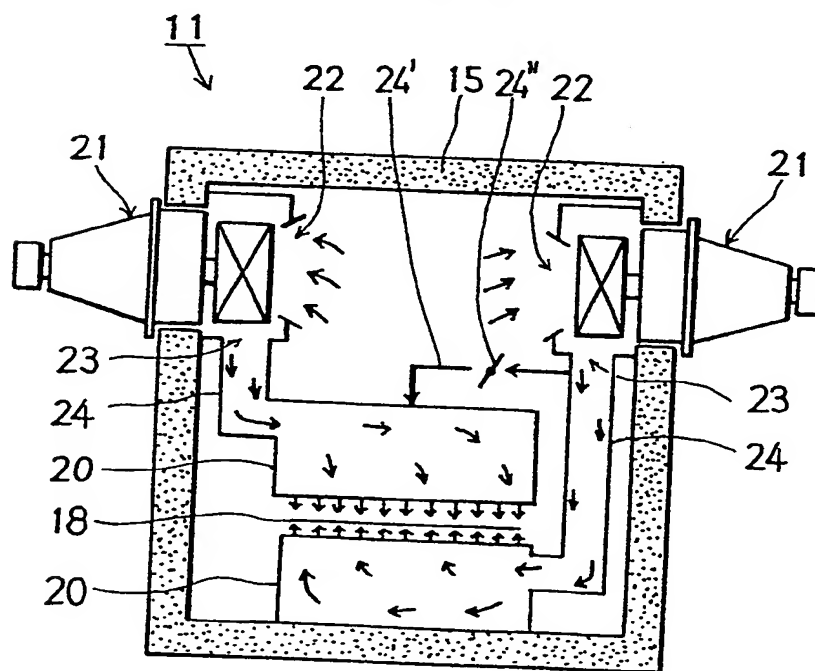


FIG. 2



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FIG. 3

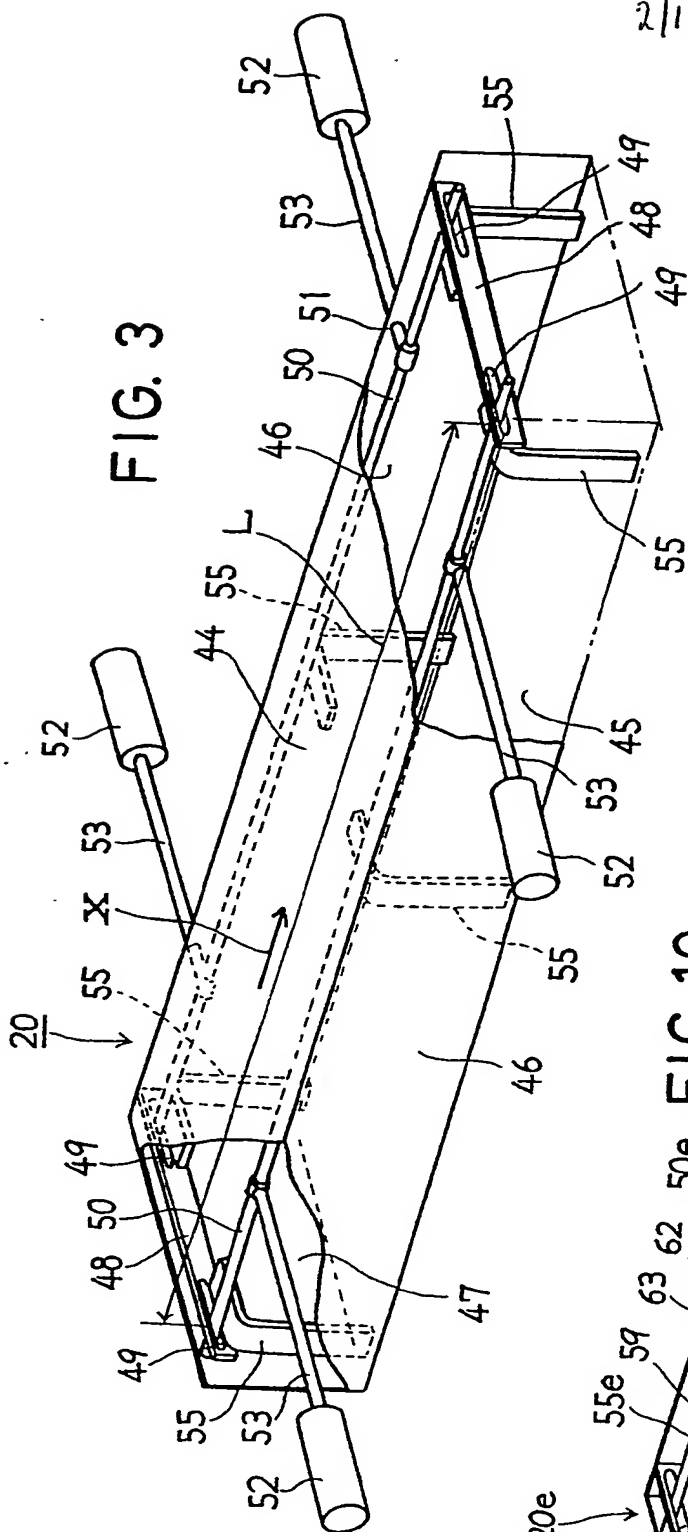


FIG. 10

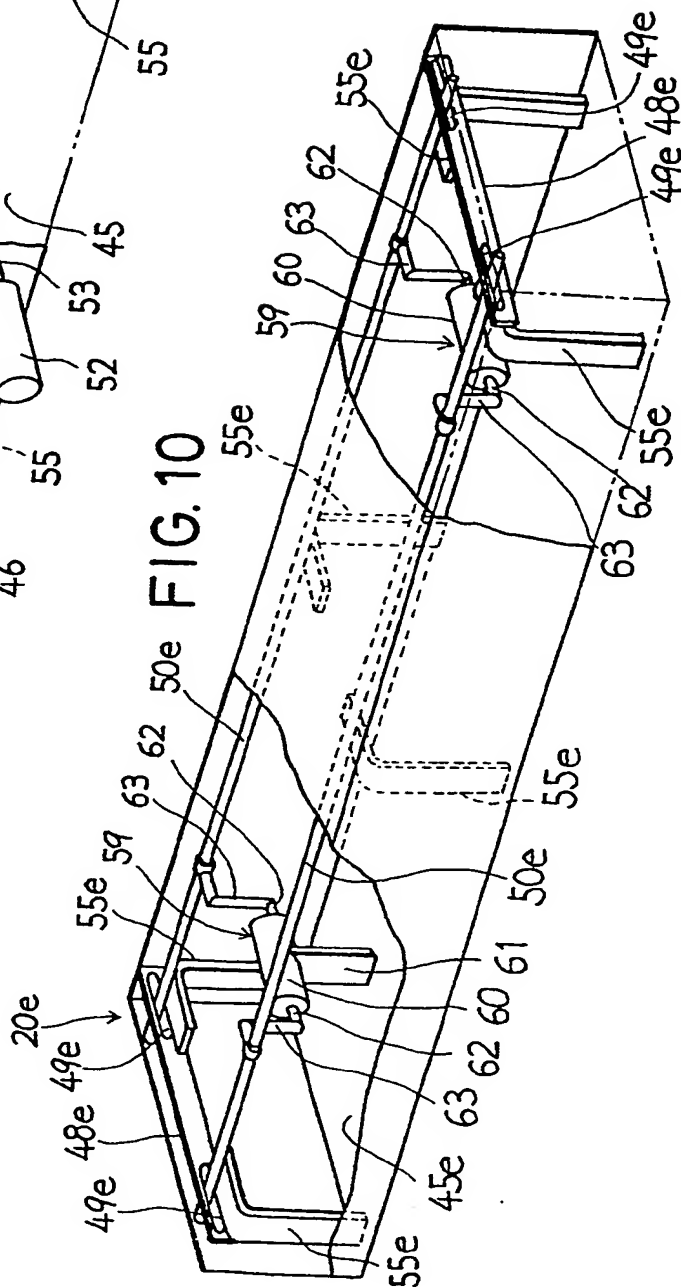


FIG. 4

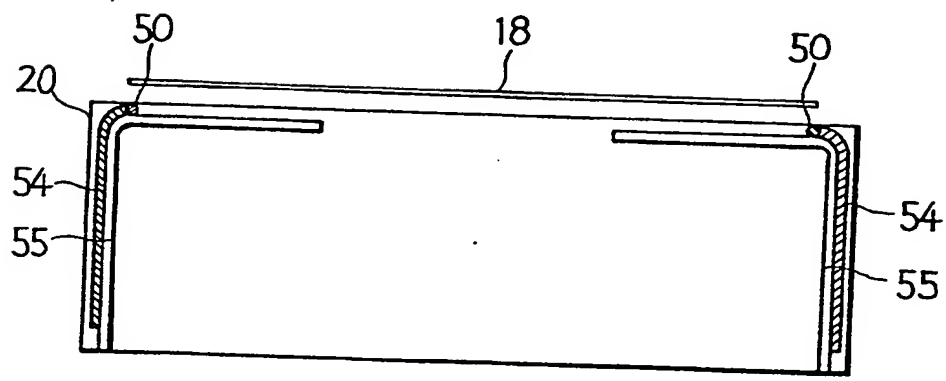


FIG. 5

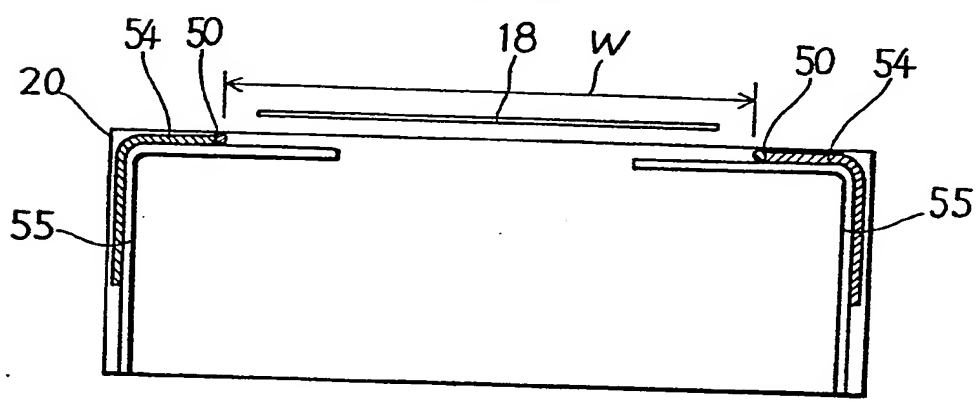
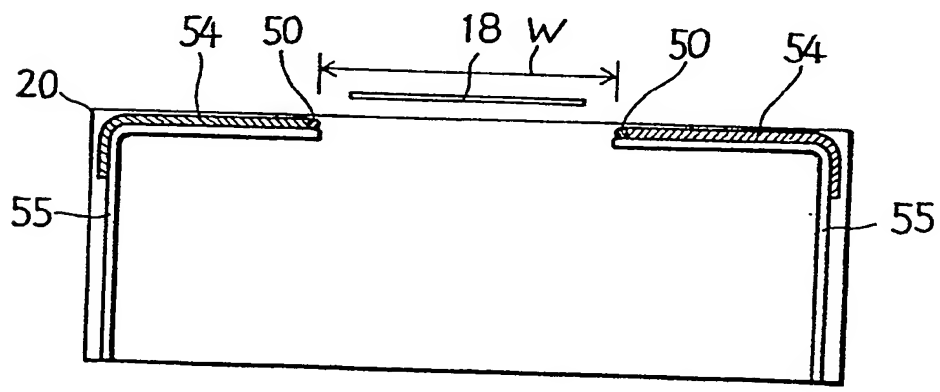


FIG. 6



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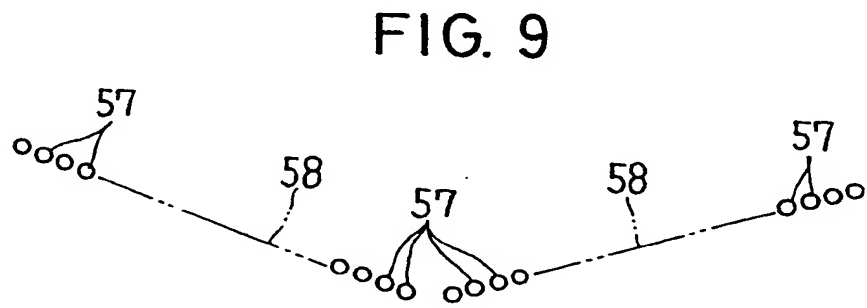
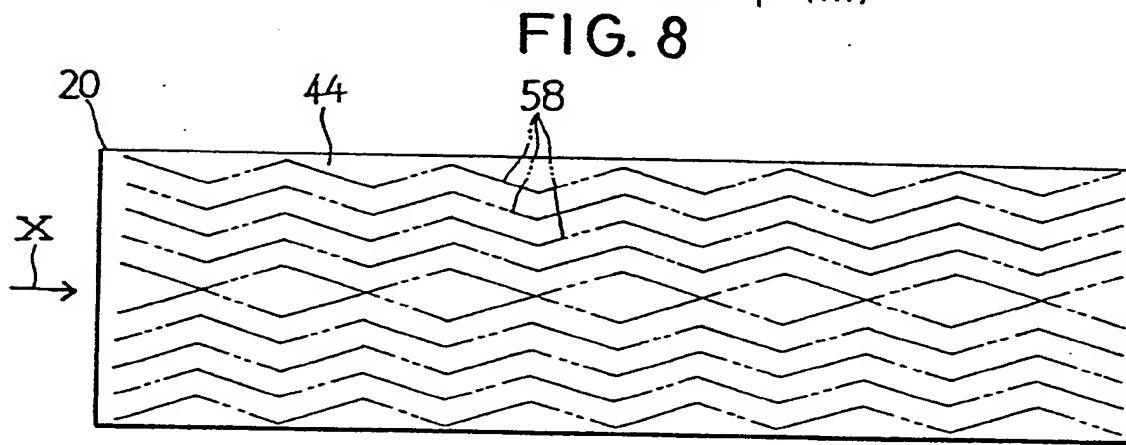
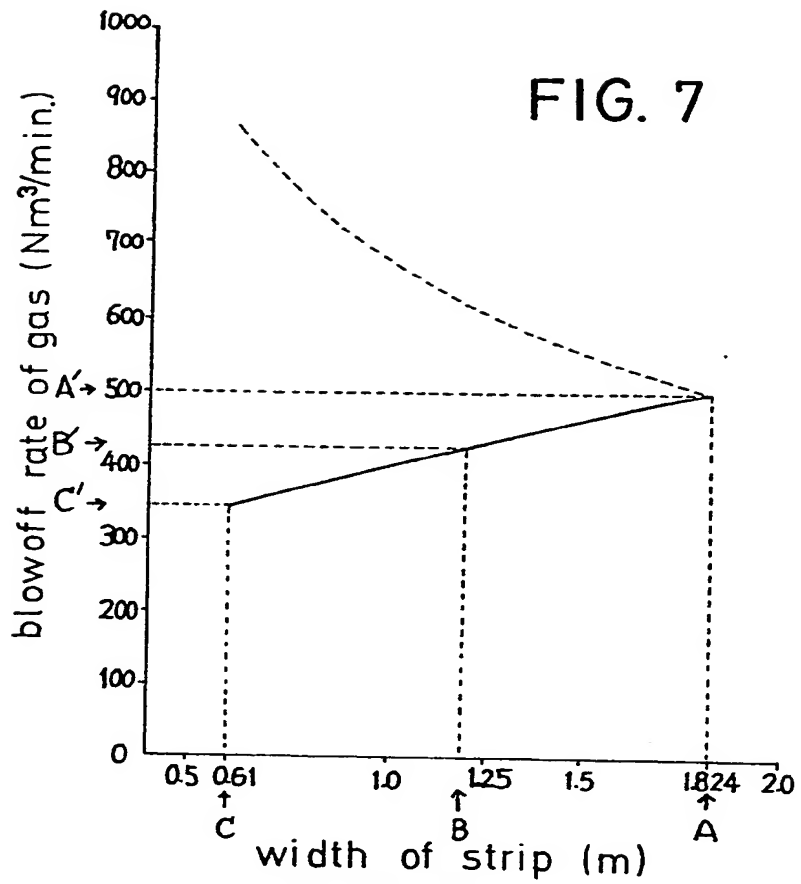


FIG. 11

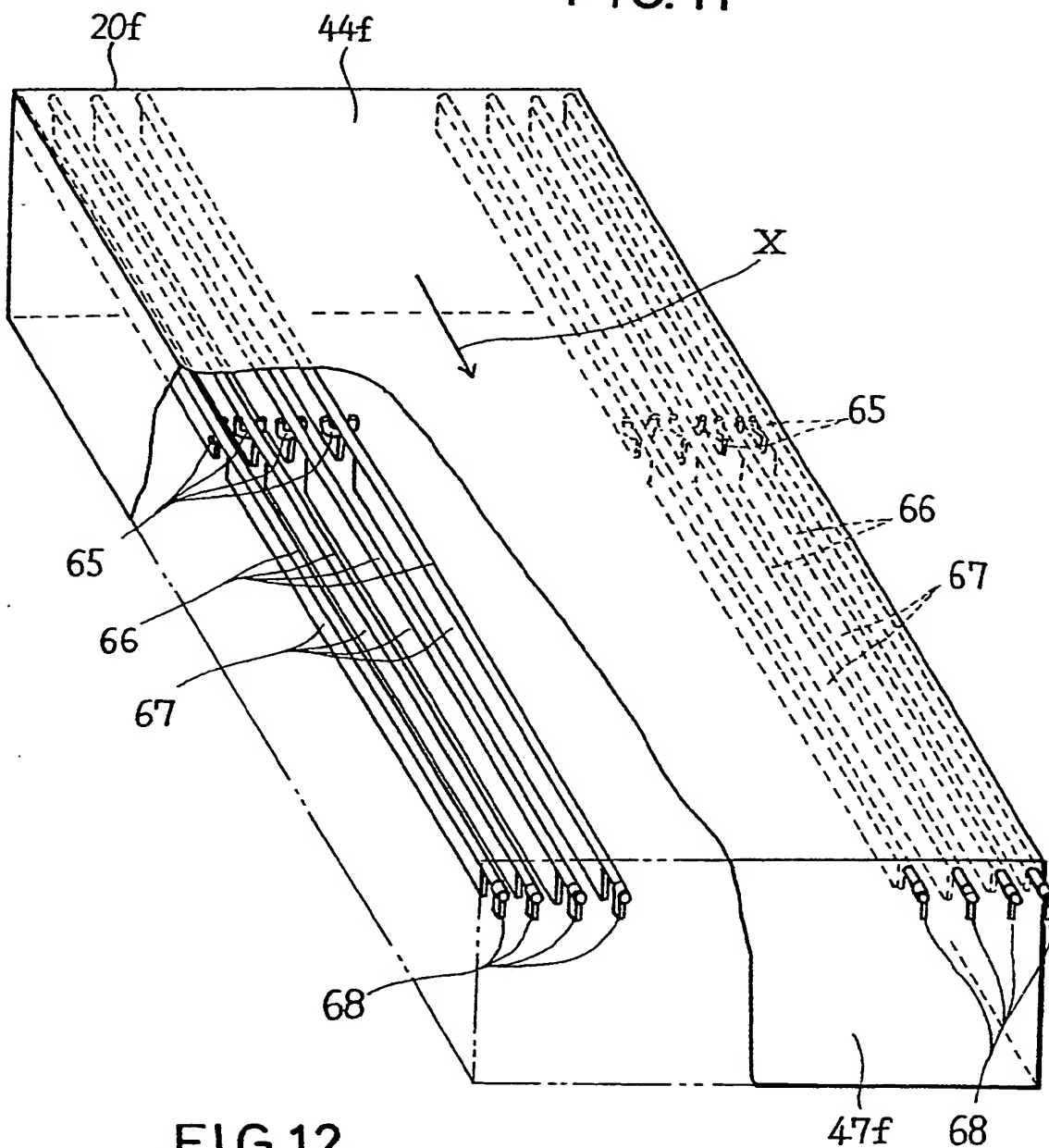
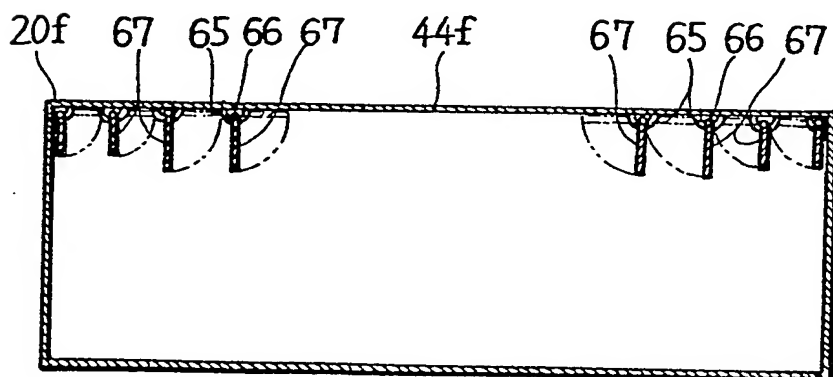


FIG. 12



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FIG. 13

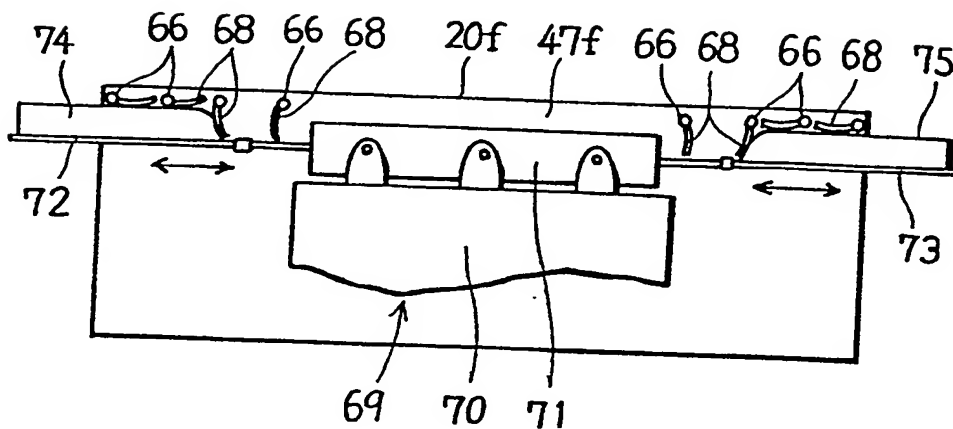


FIG. 14

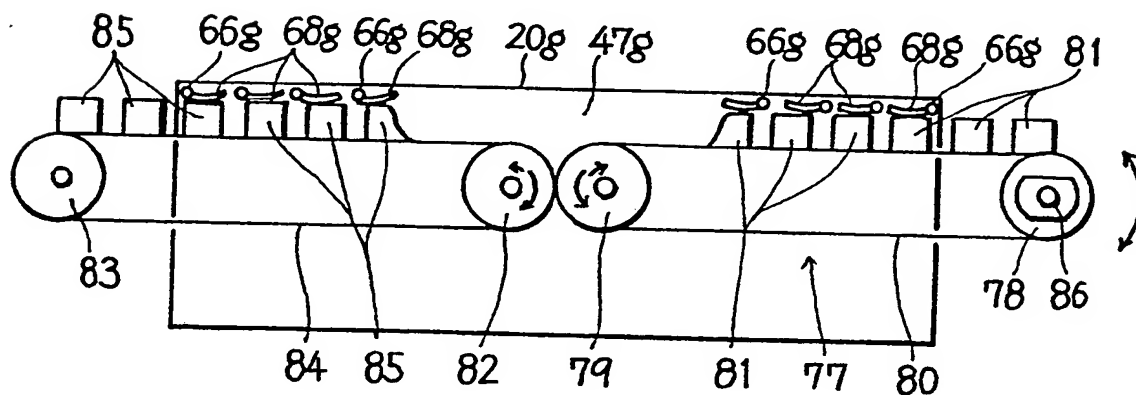
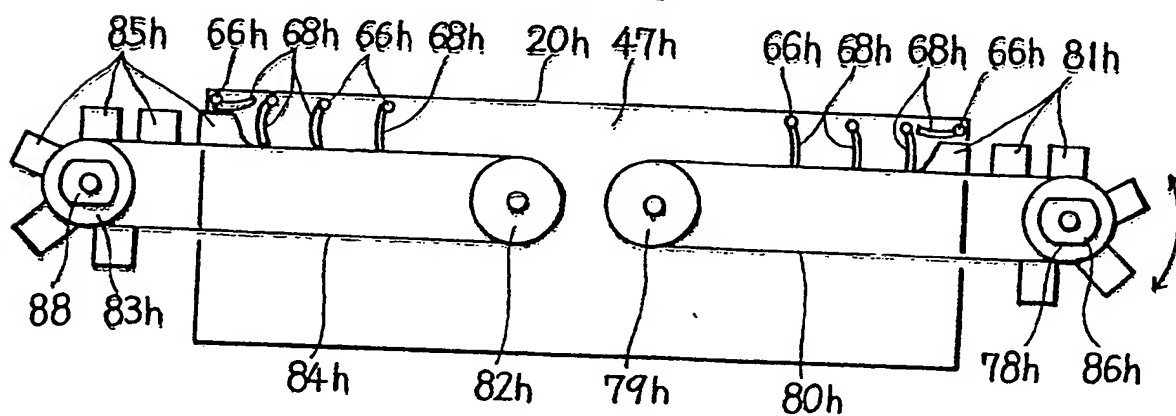


FIG. 15



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FIG. 16

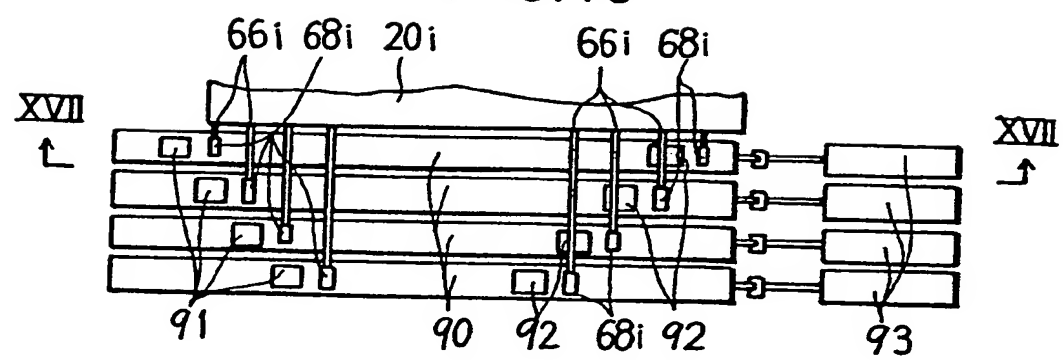


FIG. 17

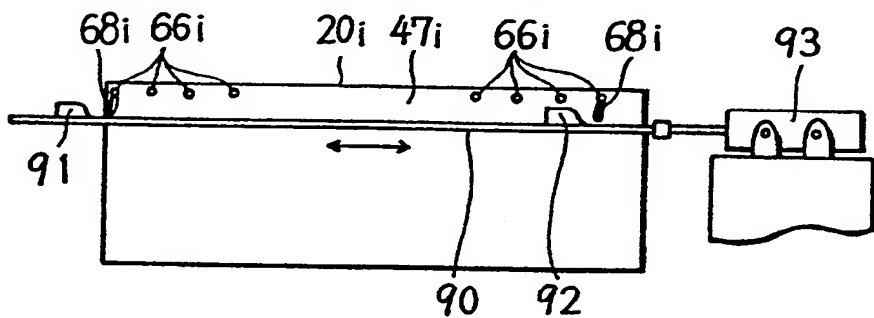
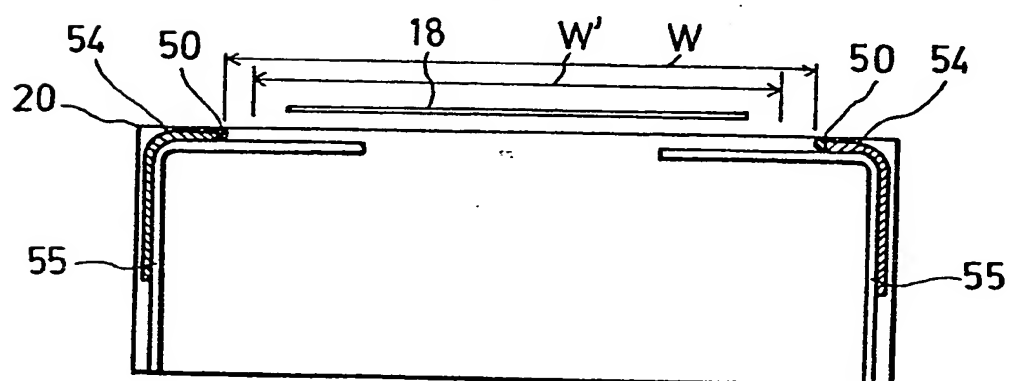


FIG. 18



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FIG. 19

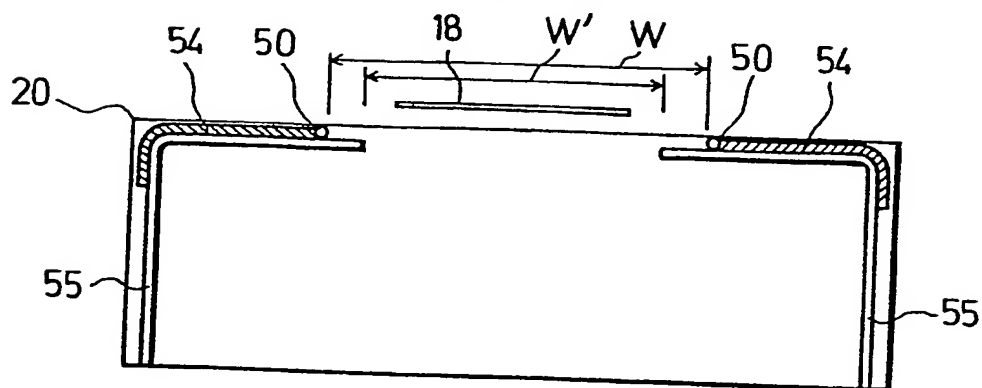
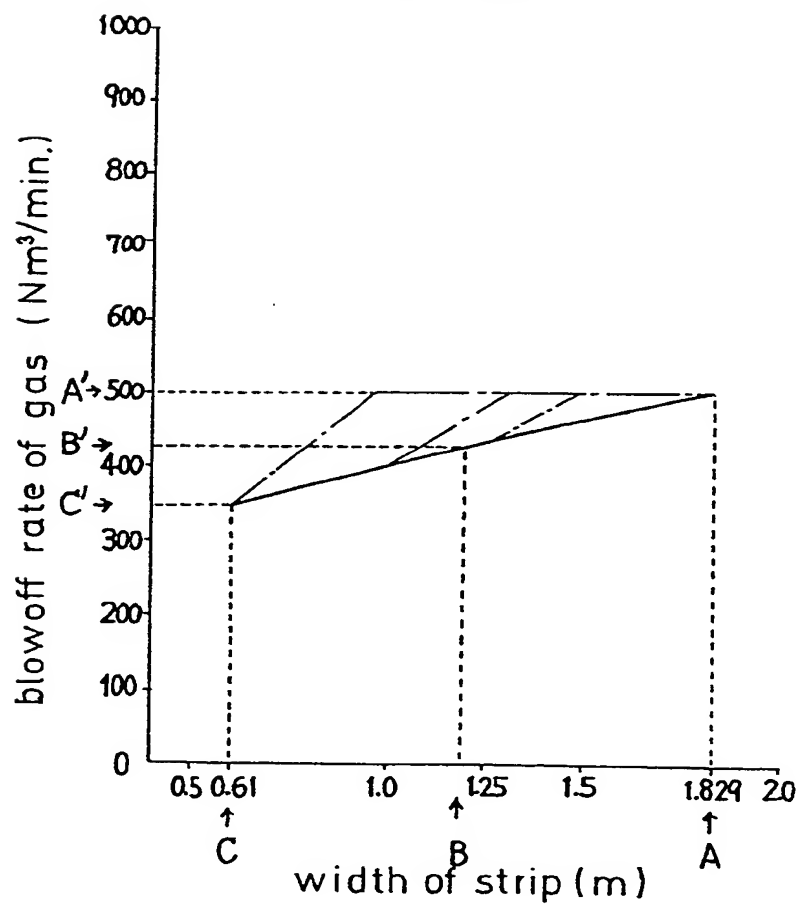


FIG. 20



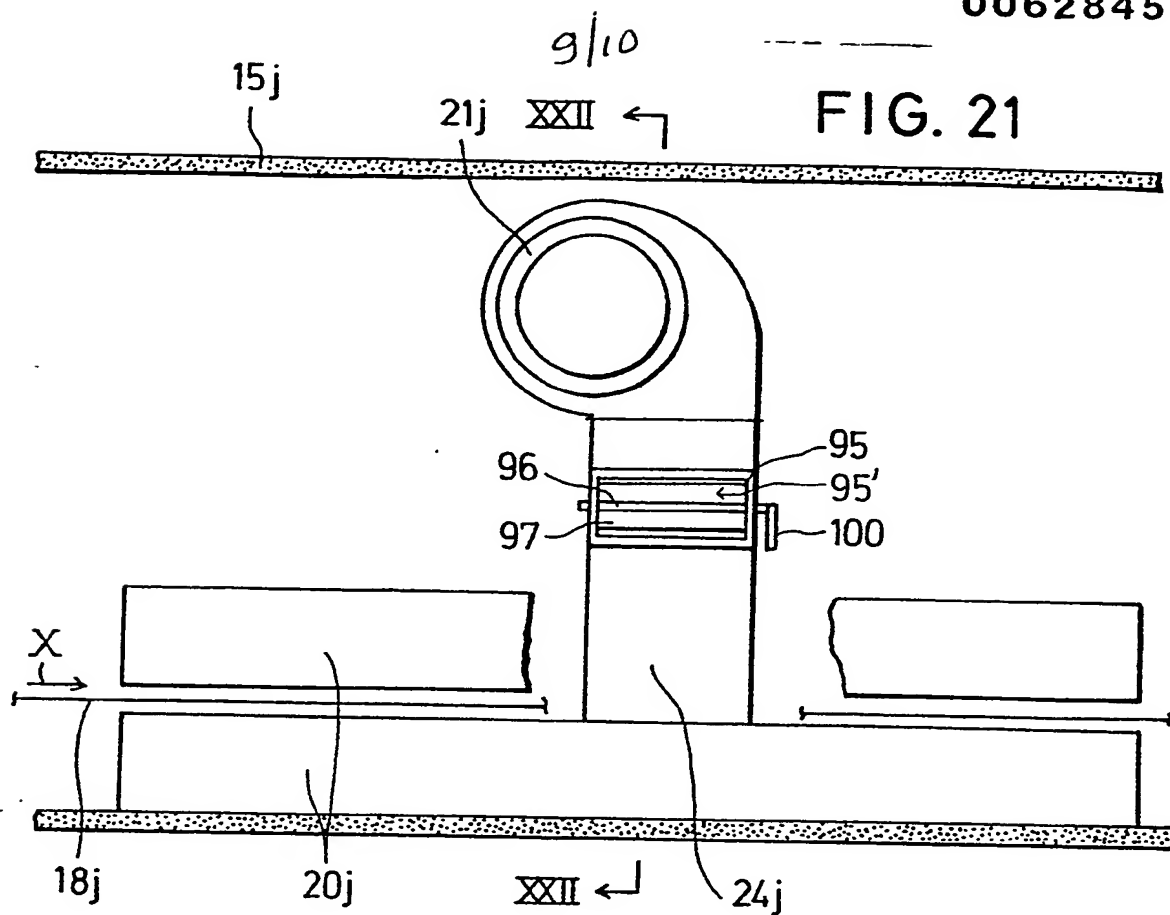


FIG. 22

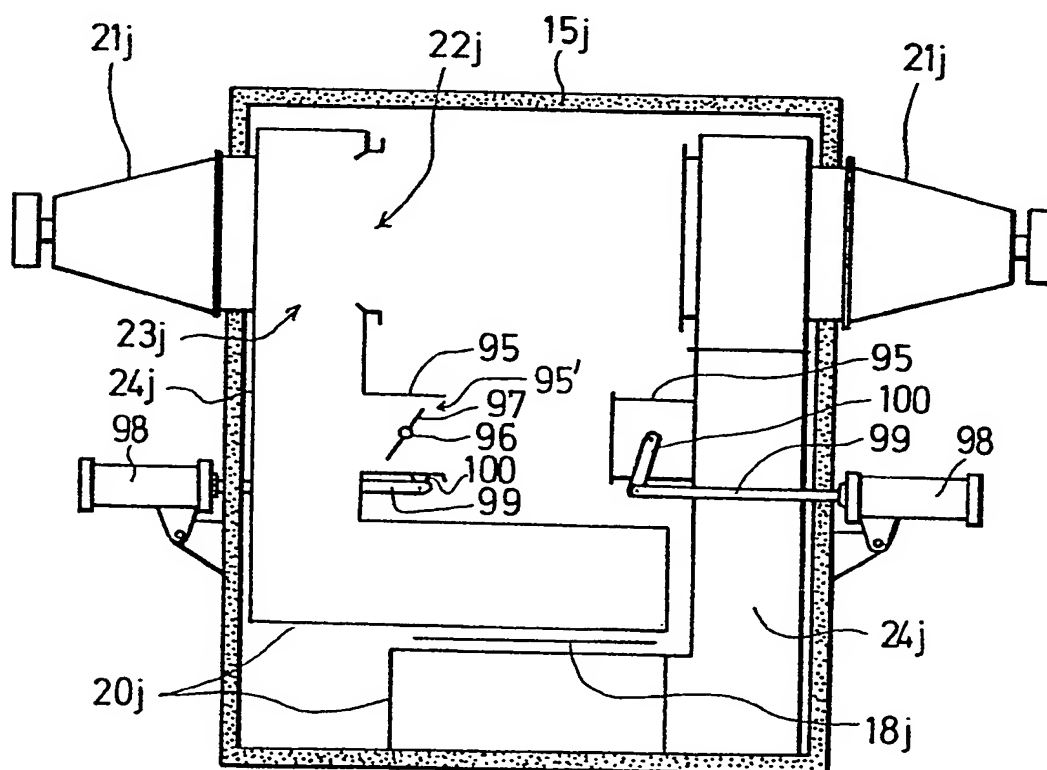


FIG. 23

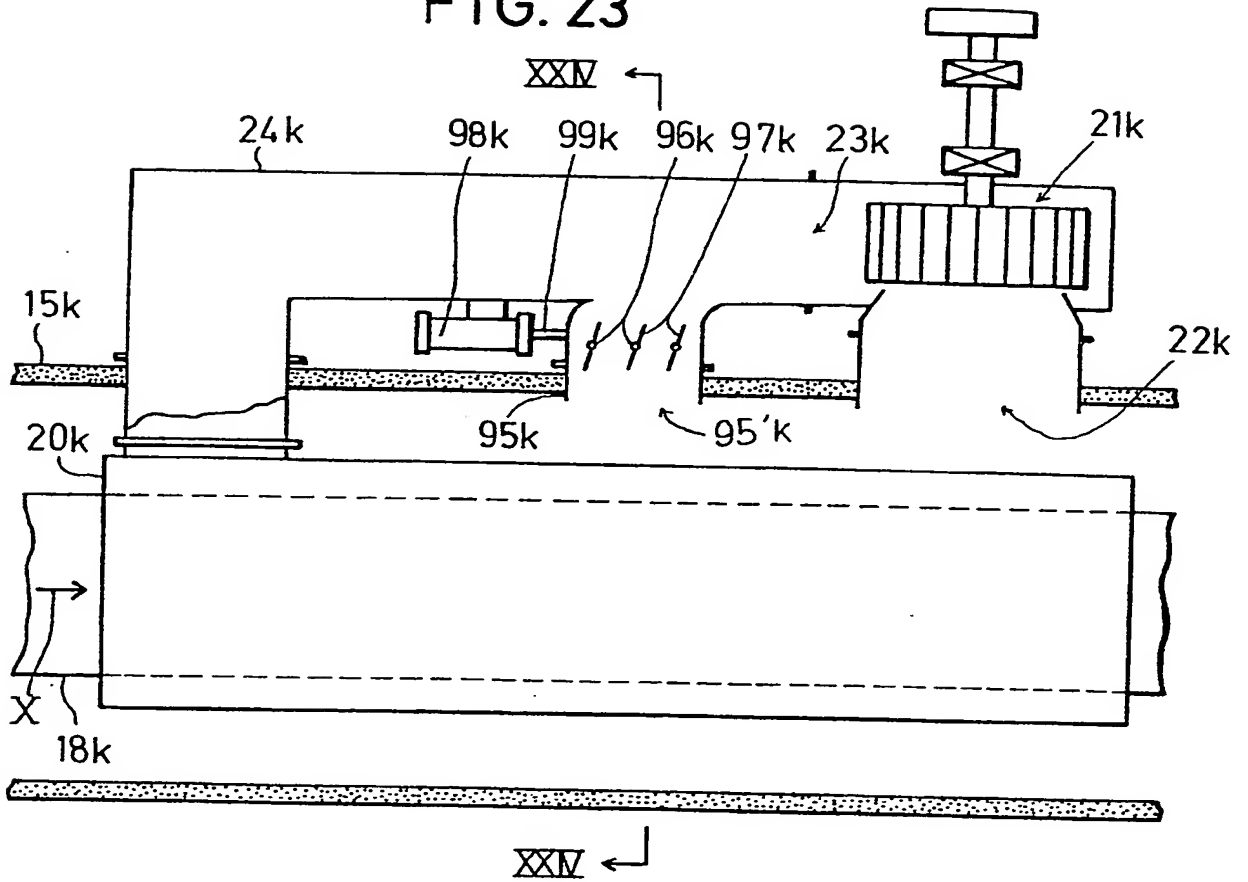


FIG. 24

